CBRFC AHPS PROJECT

A cooperative effort between:

Goals

Introduce probabilistic 14 day meteorological forecasts (ensembles) into a river forecast system.

Capture and display the uncertainty.

Verify the process.

Method

Medium Range Forecast Model

Downscale to Model Variables

Mean Areal Temperature and Precipitation Ensembles

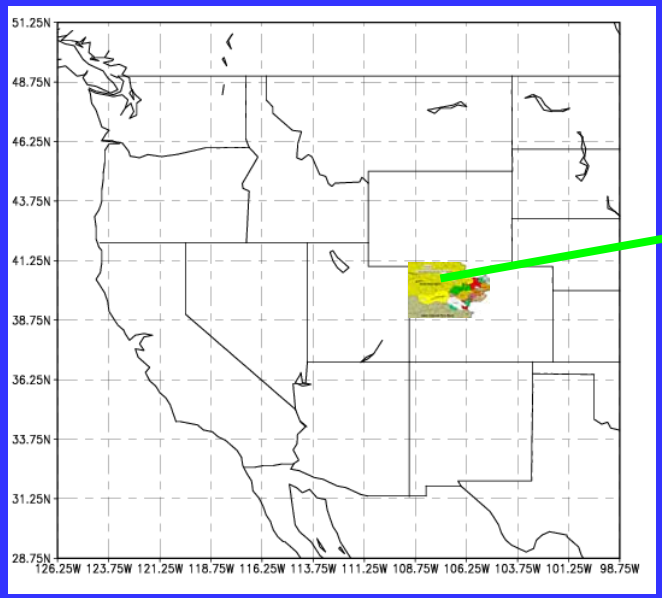
ESP Model

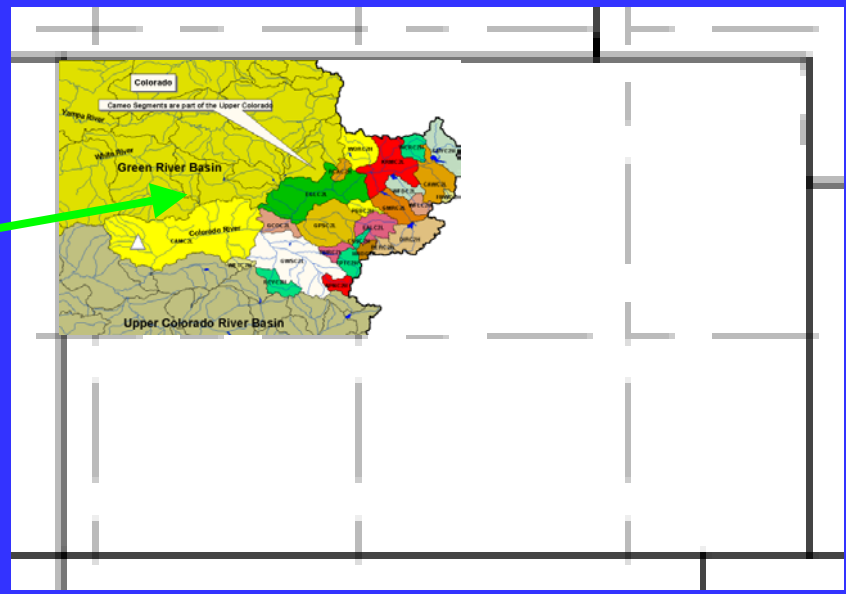
Probabilistic River Forecasts

Medium Range Forecast (MRF) Model

- Global Meteorological Model
- Many Atmospheric Variables
- Frozen Version
- Run Daily at CDC
- ~150km Spatial Resolution

MRF Spatial Resolution

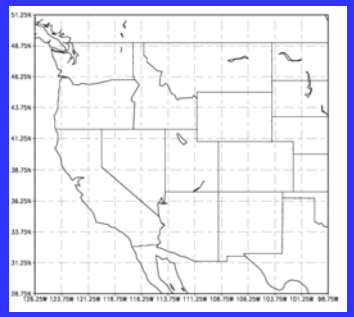


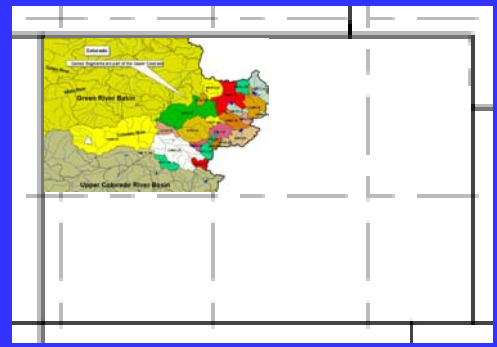


WAY TOO LARGE!

Need to Relate to Basin…

Downscaling





MRF Variables:

- 2m air temp
- Precipitation
- 700mb Relative Humidity
- Sea Level Pressure
- 10m Vector Wind
- Total Column Precipitable Water

Basin Scale Variables:

- Mean Areal Temperature
- Mean Areal Precipitation

Downscaling Method

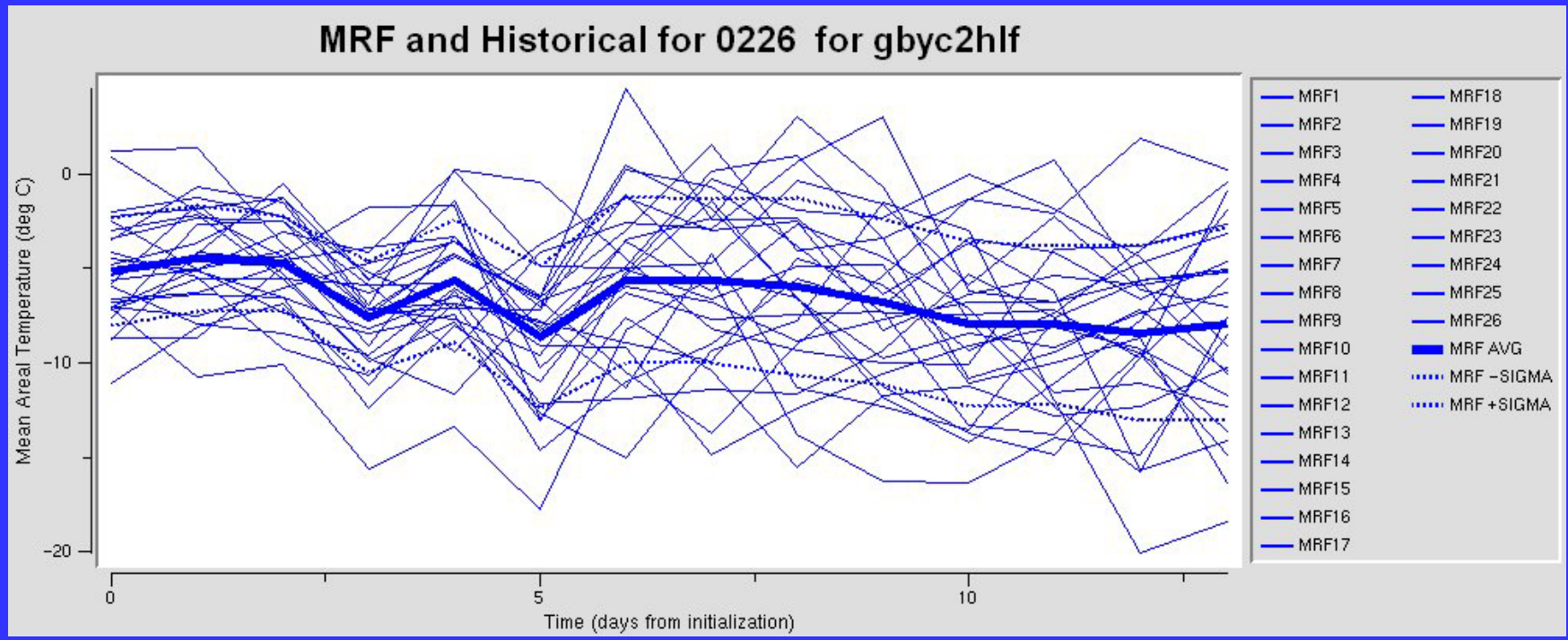
1. Relates historical MRF scale variables to historical basin scale variables through multivariate linear regression equations. For example:

   Basin MAP = a_1(MRF Precipitation) + a_2(MRF wind) + …

2. Equations developed in (1) are applied to future MRF forecasts to produce forecasts of basin scale variables.

3. Multiple values at a particular time step are generated to create ensembles.

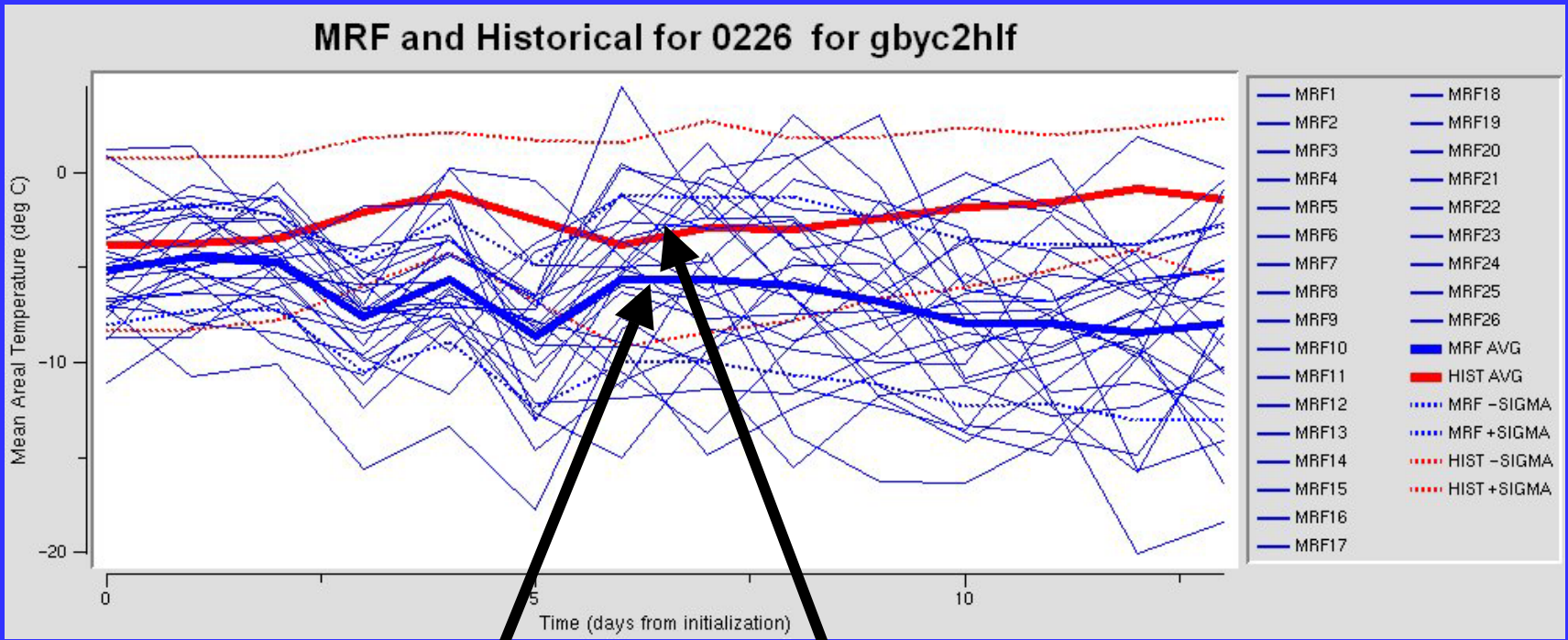
Downscaling Results



Example:

26 Ensembles of MATs for Each Sub-Basin

Downscaling Results



MRF is colder than normal in this case.

ESP Method

ESP uses initial states from the operational hydrological model along with ensembles of MAT/MAP as input.

Each ensemble is ran through the model.

Ensembles of streamflow are produced.

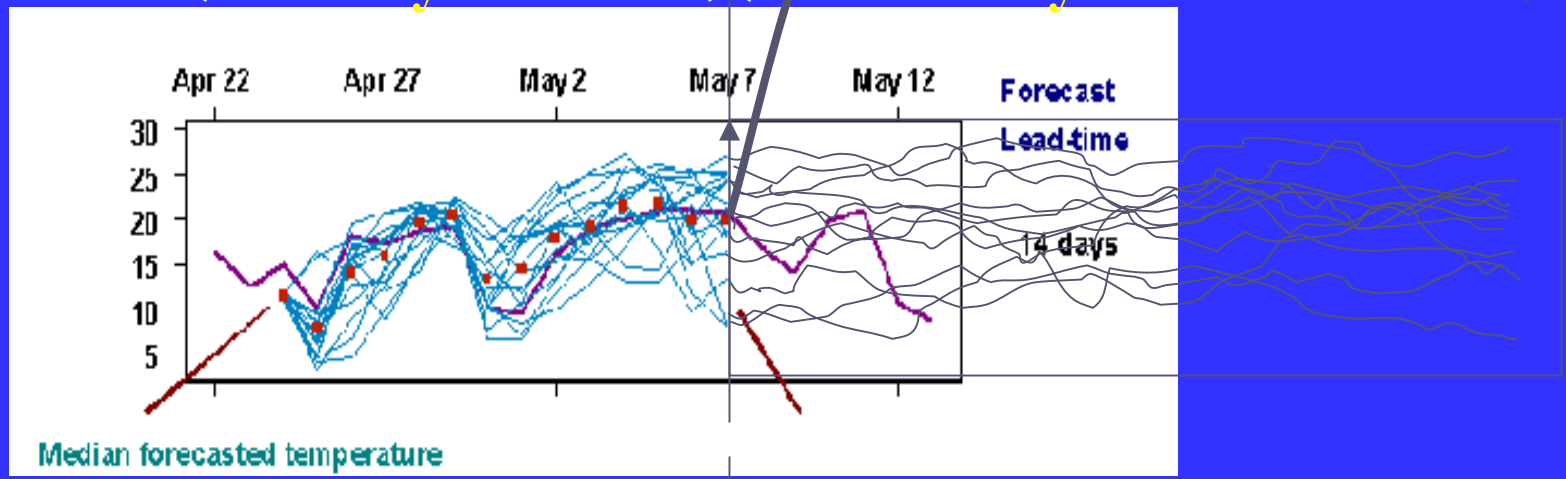
Ensemble distributions are analyzed and turned into probabilistic forecasts.

Schematic of Using Ensembles from MRF(day 1-14) As Input to ESP

Blending/Attachment

Days 1-14

Days 15-365



Ensembles From The 'Frozen' MRF

Ensembles From Historical Data

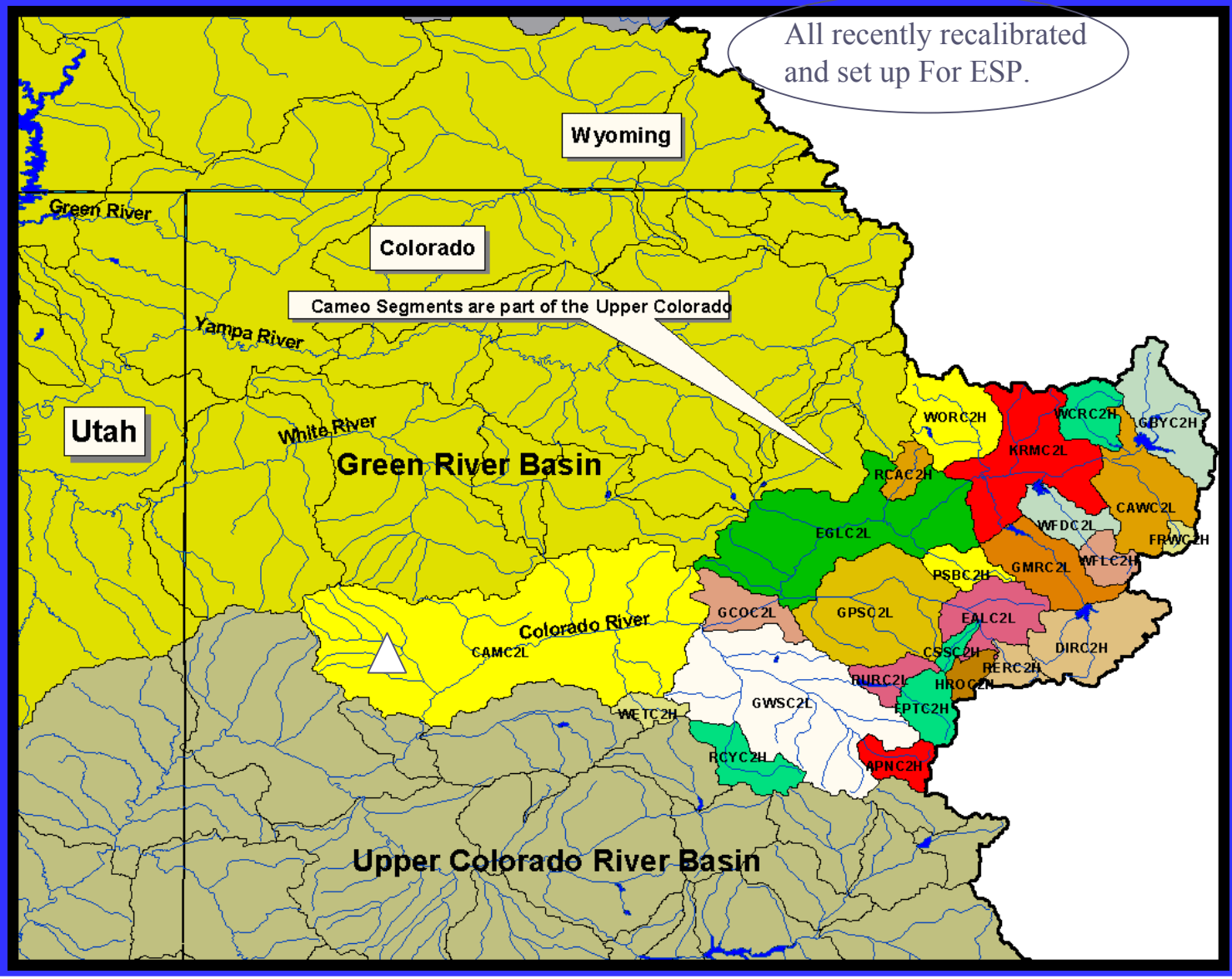
RUN ESP – EACH BASIN – TWO WAYS – EACH DAY

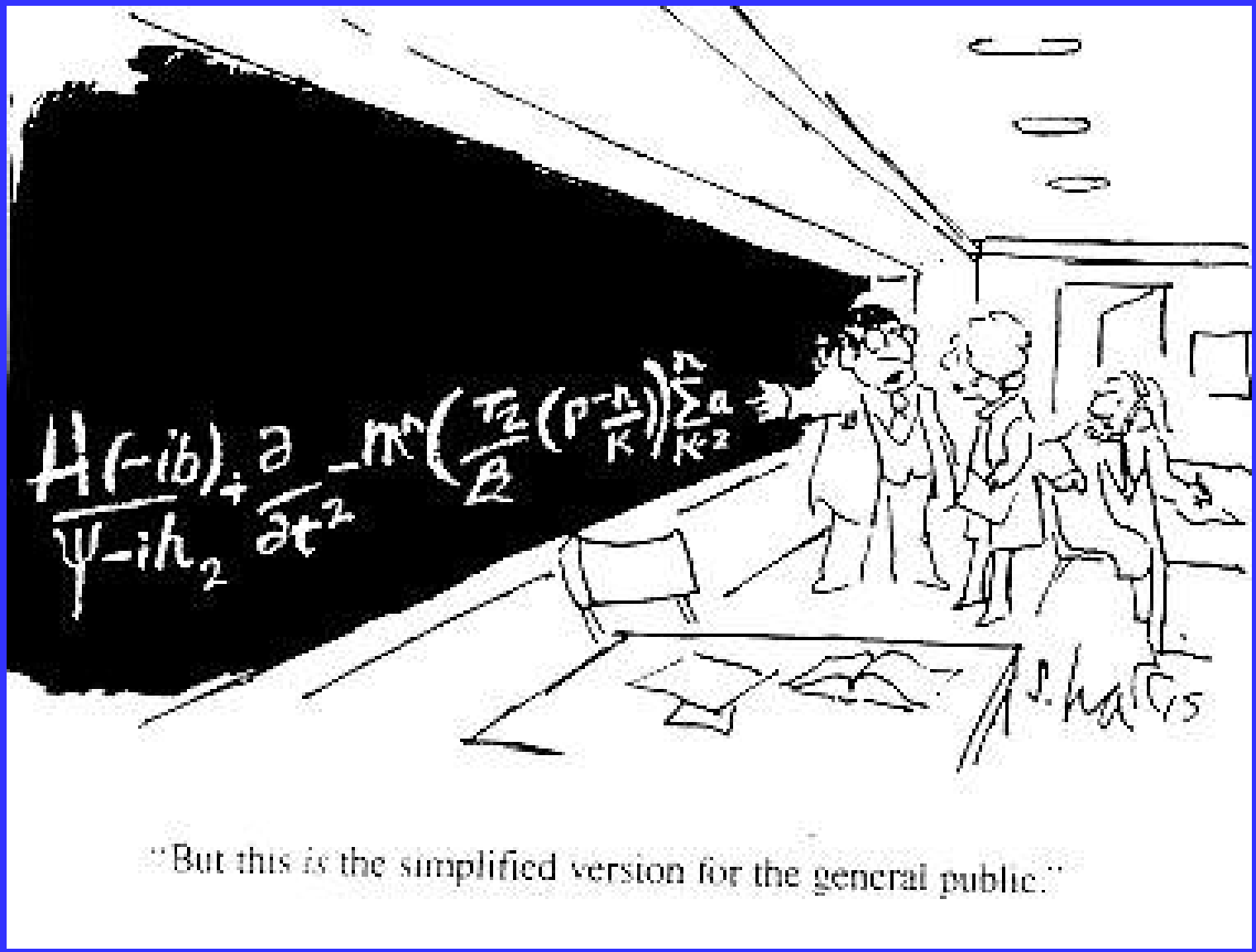
	Week 1	Week 2	Weeks 3-52
1	HISTORICAL ENSEMBLES OF MAPS/MATS – NOT WEIGHTED BY CPC FORECASTS		
2	MRF ENSEMBLES OF MAPS/MATS	HISTORICAL ENSEMBLES OF MAPS/MATS – NOT WEIGHTED BY CPC FORECASTS	

Future Plans

3	MRF ENSEMBLES OF MAPS/MATS	WxGEN ENSEMBLES OF MAPS/MATS – WEIGHTED BY DOWNSCALED CPC FORECASTS	
4	1-3 Day ETA	4-14 Day MRF	HISTORICAL ENSEMBLES OF MAPS/MATS – WEIGHTED BY CPC FORECASTS

Project Area: 27 Segments Above Cameo, Colorado River





"But this is the simplified version for the general public."

ESP Example

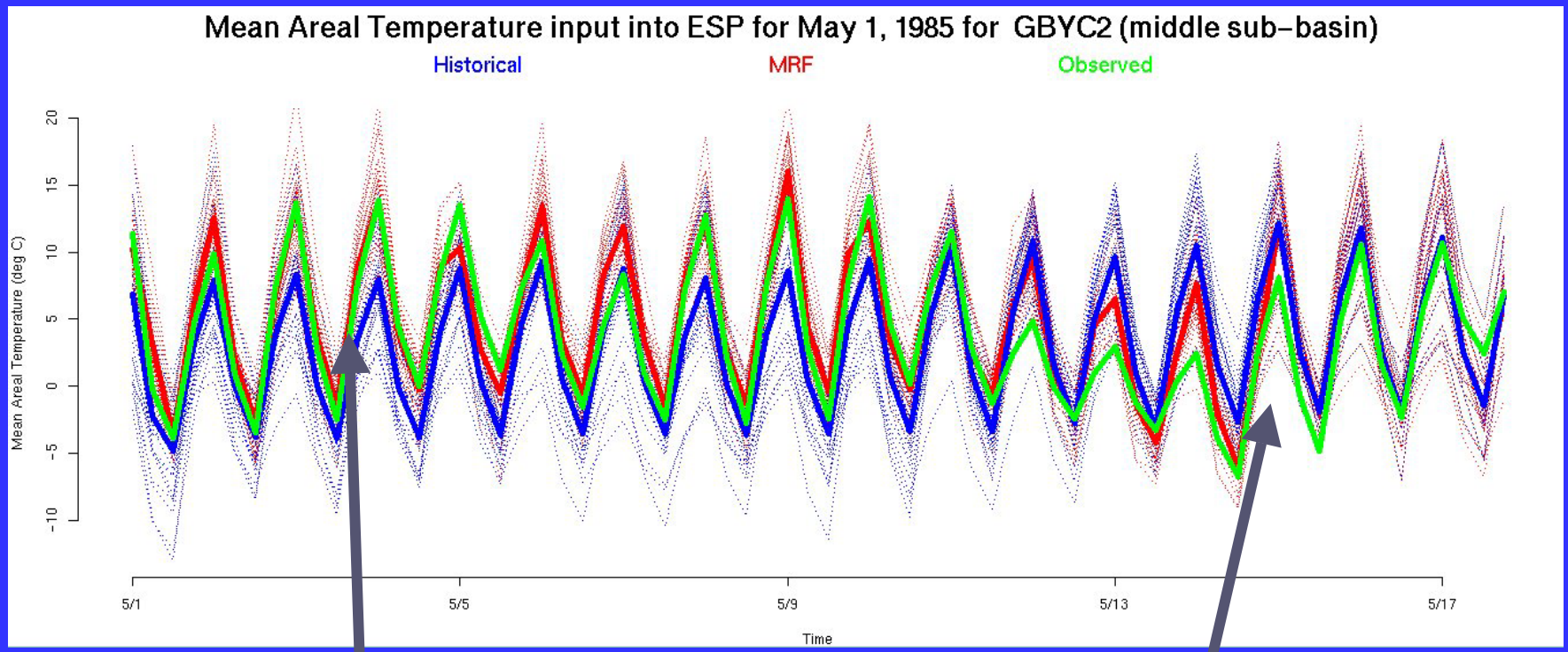
Probabilistic forecast (or model) verification requires a large dataset. This is accomplished through reforecasting.

Reforecasts done for every basin for every day between 1979 – 1999.

Reforecasts made with both reforecasted MRF and historical MAT/MAPs.

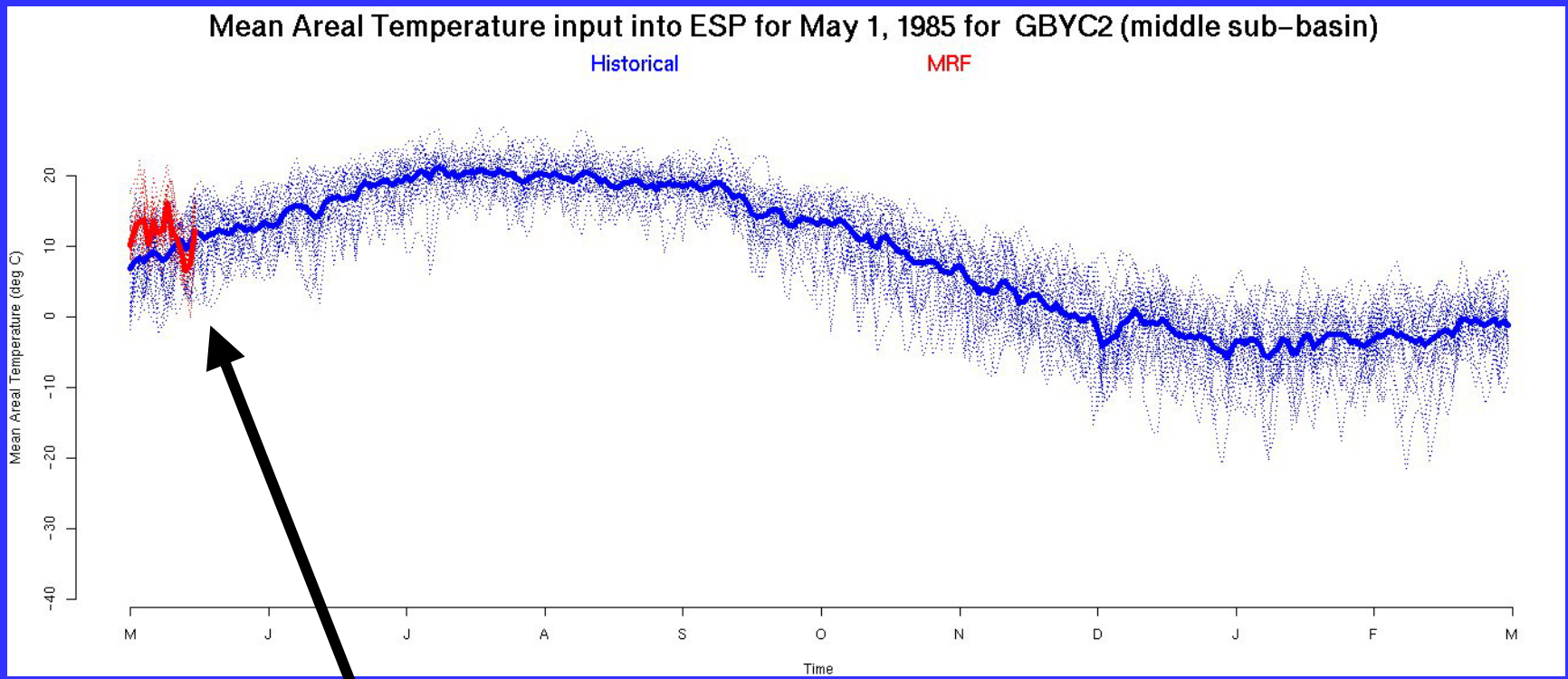
Following example from Granby, CO (GBYC2) reforecast for May 1, 1985.

Input into ESP



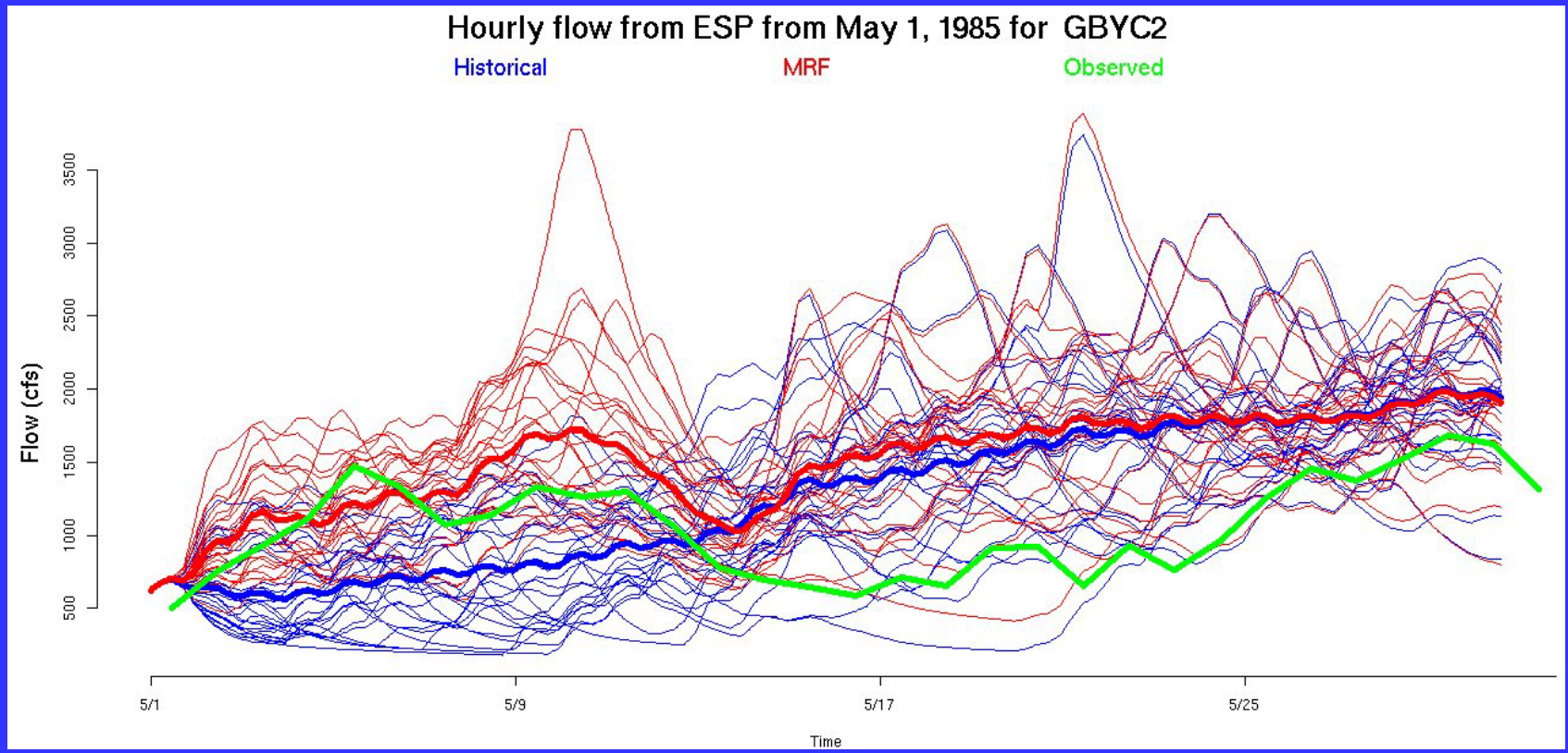
MRF derived MAT/MAPs are attached to historical years ("ensembles") and 'fed' to ESP. Note MRF is warmer in first week

Input into ESP



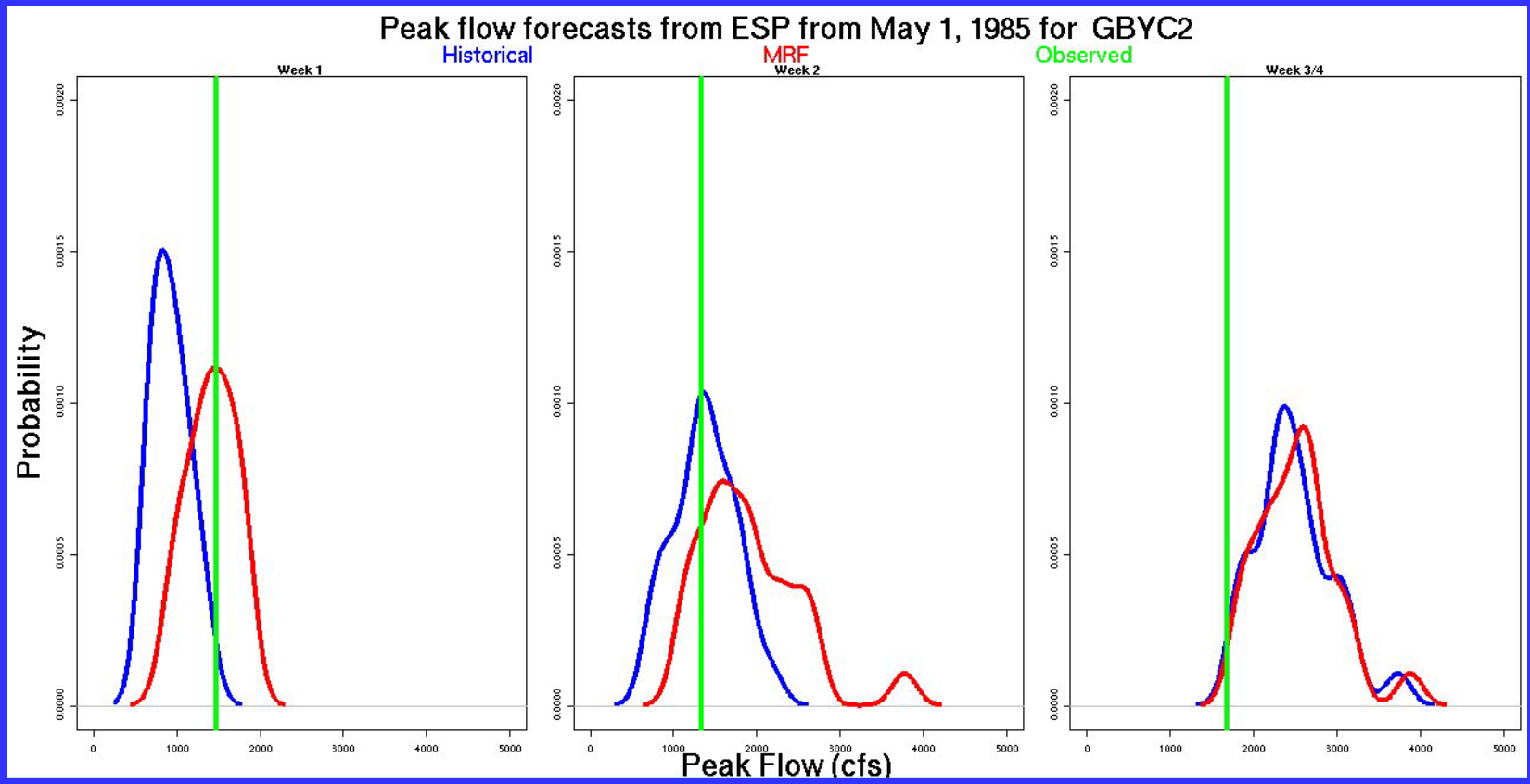
MRF derived MAT/MAPs related to the entire year of historical ensembles.

ESP flow time series



Hourly instantaneous flow ensembles are created by ESP and saved. MRF shows higher flows than historical when it is warmer (during the first week). These may be converted into probabilistic forecasts…

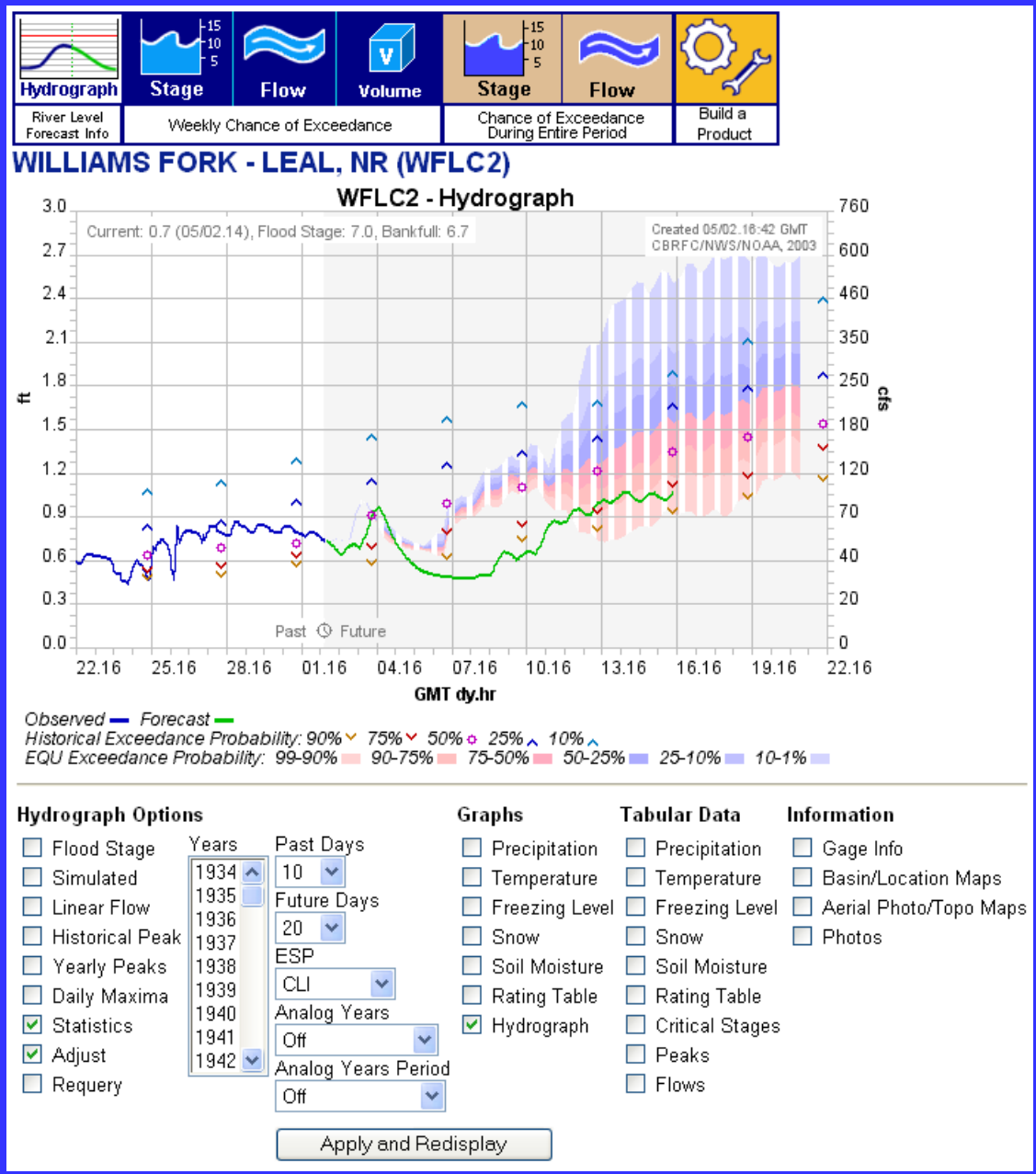
ESP peak flow



Peak flow forecasts shown as Probability Density Functions (PDFs). MRF shows higher probabilities in higher flows for two weeks.

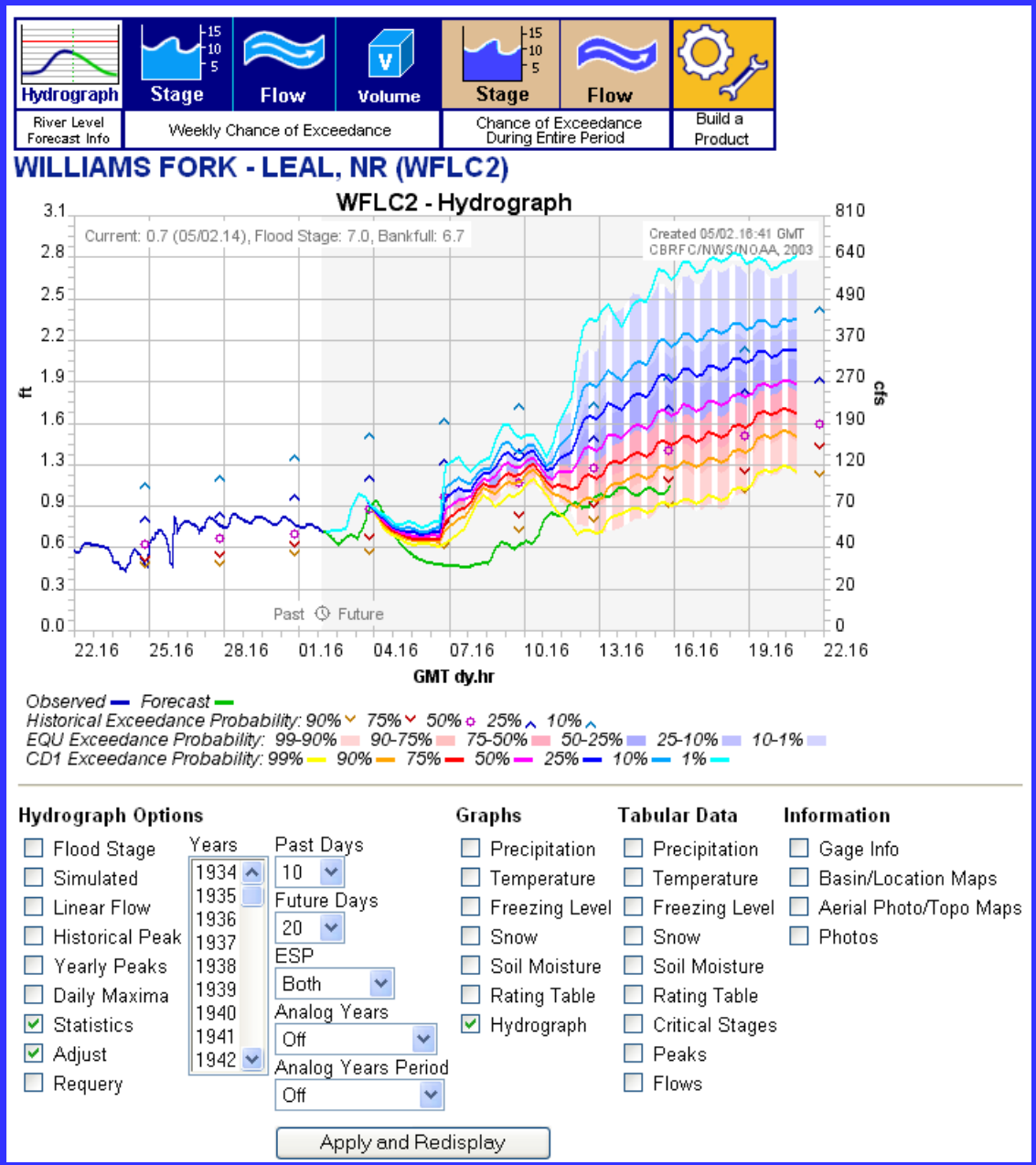
Web Page Example

Probabilities from ESP (shaded) Using Historical MAPs and MAPs Equally Weighted Plotted with Deterministic Forecast and Historical Exceedance Values



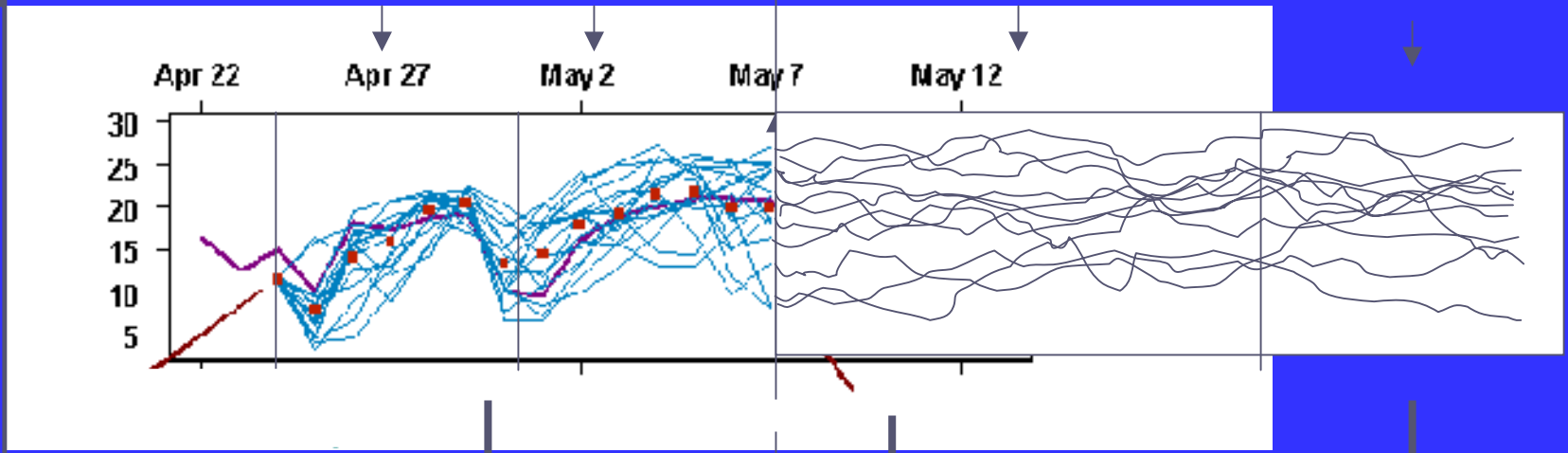
Web Page Example

Probabilities from ESP (shaded) Using Historical MAPs and MAPs Equally Weighted and ESP (lines) Using Maps And Mats Derived from The MRF Ensembles Plotted with Deterministic Forecast and Historical Exceedance Values



Information We Will Verify

Week 1 | Week 2 | Week 3 – 4 | APR-JUL

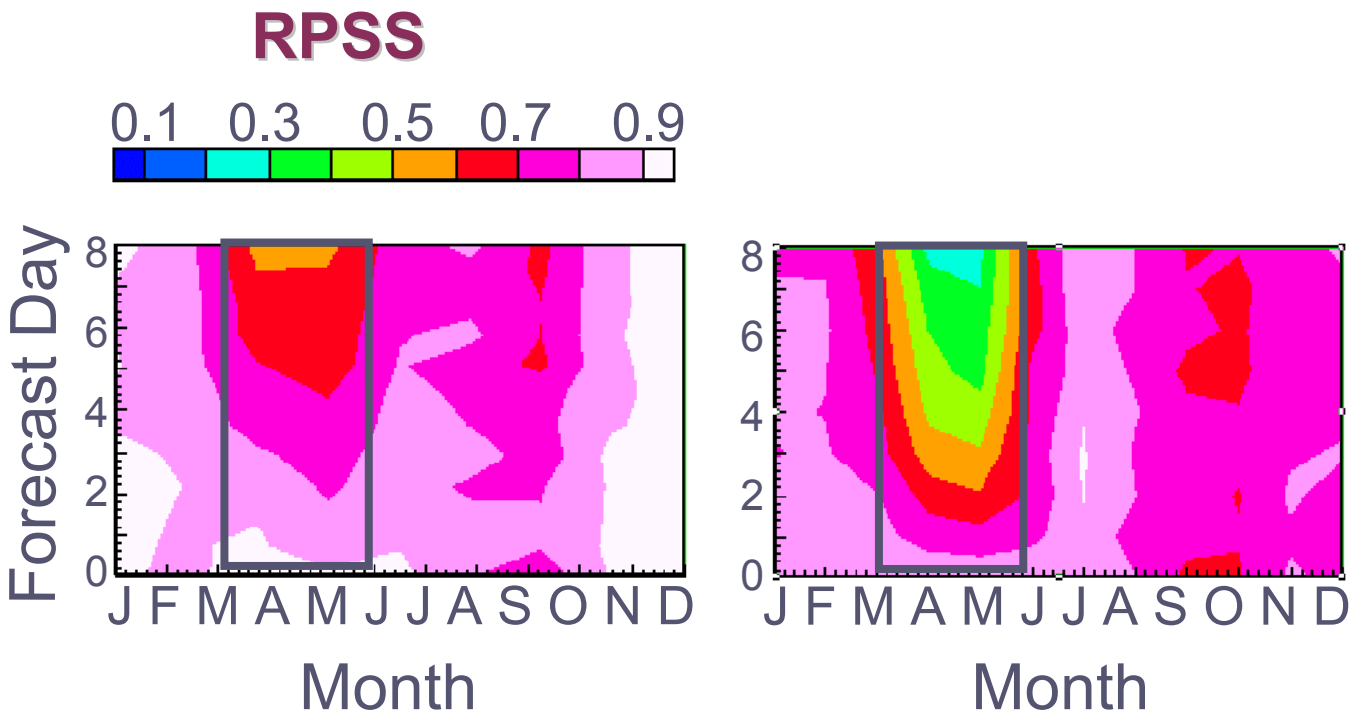


Instantaneous Flow:
6 hour time step
Volume
Peak
Various Probabilities

Volume
Peak
Various Probabilities

Seasonal Volume
Seasonal Peak
Various Probabilities

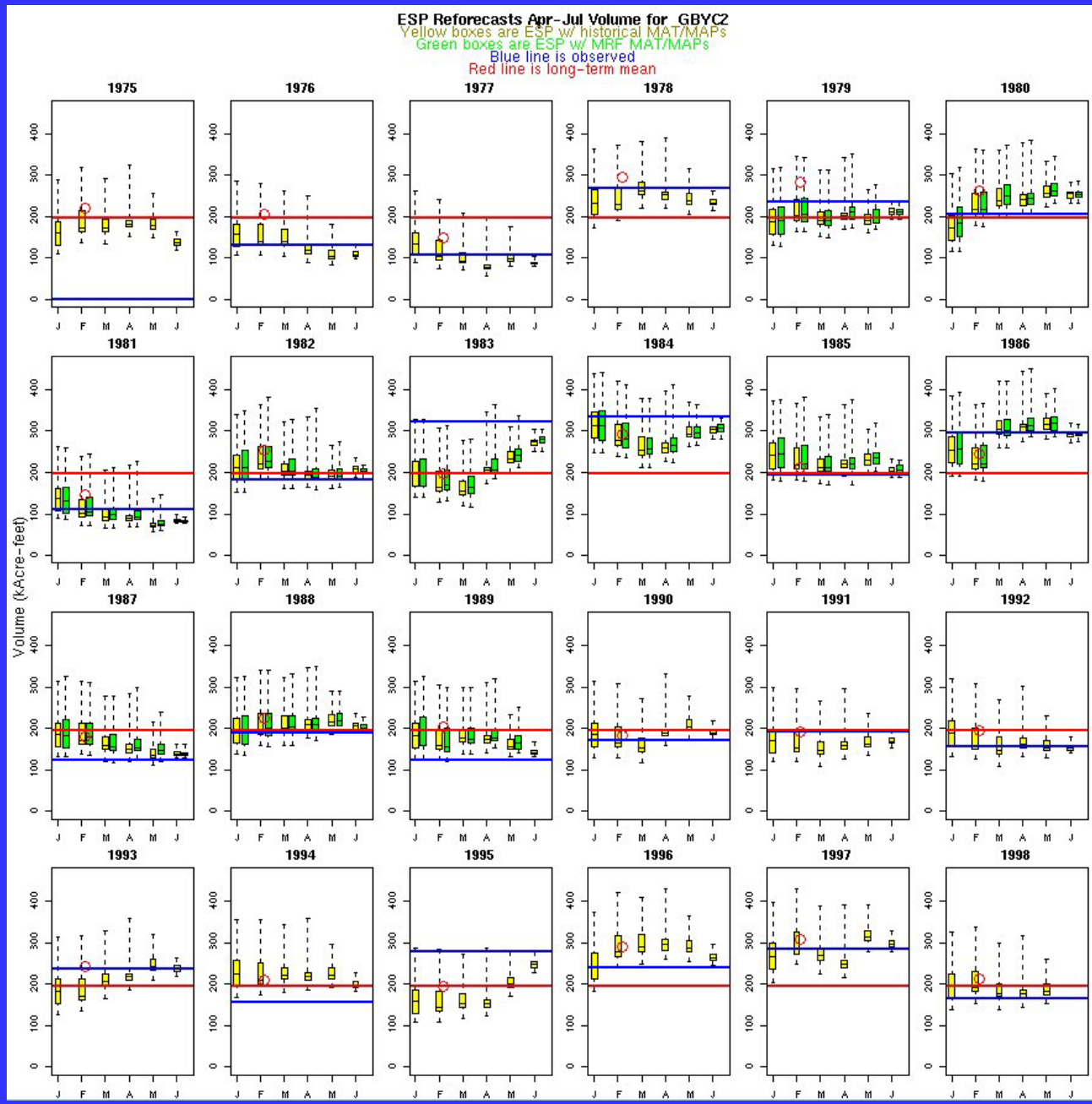
Ranked Probability Skill Score (RPSS) for each forecast day and month using measured runoff and simulated runoff produced using: (1) SDS output and (2) ESP technique



Credit: Lauren Hay, USGS, presentation: “Hydrologic Modeling in Mountainous areas”

ESP volumes

Examine how forecasts in individual years are modified by changes to input MAT/MAPs



Future Plans

Use Statistical Weather/Climate Generator In Lieu of Historical Ensembles

Use Experimental Technique to Downscale CPC Forecasts/Apply to Historical and WX/Generator – nino 3.4 composites

Use ETA Forecasts from reforecast project

More r(v)igorous verification